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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/630,970	07/31/2003	David L. O'Meara	071469-0303786	1845
909	7590	09/13/2005	EXAMINER	
PILLSBURY WINTHROP SHAW PITTMAN, LLP			DANG, PHUC T	
P.O. BOX 10500			ART UNIT	
MCLEAN, VA 22102			PAPER NUMBER	

2818

DATE MAILED: 09/13/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/630,970

Applicant(s)

O'MEARA ET AL.

Examiner

PHUC T. DANG

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on amendment filed July 20, 2005.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-26 and 28-44 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-26 and 28-44 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 31 July 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>042205</u> . | 6) <input type="checkbox"/> Other: _____ |

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Response to Arguments

1. Applicant's arguments filed on July 20, 2005 with respect to claims 1-26 and 28-44 have been fully considered but that are not persuasive.

Information Disclosure Statement

2. The office acknowledges receipt of the following items from the applicant:

Information Disclosure Statement (IDS) filed on April 22, 2005.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-4, 6-21 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Niimi et al., hereinafter "Niimi" (U.S. Patent No. 6,503,846 B1).

Regarding claim 1, Niimi discloses an apparatus and a method of forming a semiconductor microstructure comprising:

positioning a substrate (101, Fig. 4A) in a process chamber [col. 4, line 24];

flowing a process gas comprising a nitrogen-containing oxidizing gas in the process chamber [col. 4, lines 18-24]; and

forming an oxynitride layer (103, Fig. 4A) on the substrate (101, Fig. 4A), the oxynitride layer being formed in a thermal oxidation process, wherein the partial pressure of the nitrogen-containing oxidizing gas in the process chamber is less than about 10 Torr [col. 4, lines 16-35].

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Niimi discloses all the features of the claimed invention as discussed above, but does not disclose the oxynitride layer being formed in a self-limiting thermal oxidation process.

Self-limiting thermal oxidation process is defined by the oxidation is applied at the low partial pressure of the processing gas comprising nitrogen-containing oxidizing gas as suggested by Niimi in col. 5, lines 52-56.

Thus, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the teaching of Niimi as discussed above such that the oxynitride layer being formed in a self-limiting thermal oxidation process for a purpose of improving the semiconductor microstructure.

Regarding claims 2-4, Niimi discloses the range of the thickness of the oxynitride formed in the process [col. 4, lines 23-24].

Regarding claims 6 and 23, Niimi discloses the partial pressure of the nitrogen-containing oxidizing gas in the process chamber is less than about 5 Torr [col. 4, lines 34-35].

Regarding claim 7, Niimi discloses wherein the nitrogen-containing oxidizing gas comprises at least one of NO, N₂O, and NH₃ [col. 4, lines 39-41].

Regarding claim 8, Niimi discloses the process further comprises an oxygen-containing gas [col. 6, lines 12-15].

Regarding claim 9, Niimi discloses wherein the oxygen-containing gas comprises at least one of O₂, O₃, H₂O, and H₂O₂ [col. 6, lines 16-23].

Regarding claim 10-11, Niimi discloses the process further comprises an inert gas which comprising at least one of Ar, He, Ne, Kr, Xe, N₂ [col. 4, lines 38-39].

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Regarding claims 12-13, Niimi discloses the substrate temperature is between about 500°C and about 1000°C [col. 6, lines 41-43].

Regarding claim 14, Niimi discloses wherein the substrate comprises Si and the oxynitride layer comprises SiOxNy [col. 2, lines 61-65].

Regarding claims 15-16, Niimi discloses comprising exposing the oxynitride layer to a plasma nitridation process where the nitridation process utilizes a process gas comprising at least one of N₂, NO, N₂O and NH₃ [col. 4, lines 38-42].

Regarding claim 17, Niimi discloses a step of further comprising post-annealing the oxynitride layer using a process gas comprising at least one of N₂O and O₂ [col. 4, lines 37-42].

Regarding claim 18, Niimi discloses wherein the positioning comprises positioning a substrate containing an initial dielectric layer in a process chamber [col. 2, lines 61-65].

Regarding claims 19-21, Niimi discloses wherein the initial dielectric layer which comprises at least one of an oxide (SiO₂) layer, an oxynitride (SiOxNy) layer, and a nitride (SiNx) layer is formed in a self-limiting oxidation process [col.2, lines 61+].

4. Claims 24-26 and 28-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Niimi in view of Park et al., hereinafter "Park" (U.S. Patent No. 6,825,518 B2).

Claim 24 is rejected under the same rationale sets forth to the above claim 1, except for a high-k layer deposited on the oxynitride layer; and an electrode layer on the high-k layer.

Park, however, discloses an apparatus and a method for fabricating a capacitor comprises a high-k layer (5) deposited on the oxynitride layer (4); and an upper electrode layer (6) on the high-k layer (5) (see col. 2, lines 14-15).

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It would have been obvious to one having ordinary skilled in the art at the time the invention was made to modify the teaching the controller that controls the processing system of Niimi as taught Park for a purpose of reducing the thickness of the dielectric layer.

Regarding claims 25-26, Niimi discloses the range of the thickness of the oxynitride formed in the process [col. 4, lines 23-24].

Regarding claims 28-19, Park discloses the high-k layer comprises at least one of HfO_2 , ZrO_2 , Ta_2O_5 , TiO_2 , Al_2O_3 and HfSiO and the electrode layer comprises at least one of W, Al, TaN, TaSiN, HfN, HfSiN, TiN, TiSiN, Re, Ru and SiGe (col. 2, lines 14-15 and col. 4, lines 34-36).

It would have been obvious to one having ordinary skilled in the art at the time the invention was made to modify the teaching the materials of the high-k layer and the electrode layer of Niimi as taught Park for a purpose of reducing the thickness of the dielectric layer.

5. Claim 30 is rejected under 35 U.S.C. 103(a) as being unpatentable over Niimi in view of Subramony et al., hereinafter "Subramony" (U.S. Publication No. US 2003/0138562 A1).

Claim 30 is rejected under the same rationale sets forth to the above claim 1, except for a controller that controls the processing system.

Subramony, however, discloses a controller (900, Fig. 5) that controls the processing system (490, Fig. 5) [[0046] page 4].

It would have been obvious to one having ordinary skilled in the art at the time the invention was made to modify the teaching the controller that controls the processing system of Niimi as taught Subramony for a purpose of improving the semiconductor microstructure.

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6. Claims 31-42 are rejected under 35 U.S.C. 103(a) as being unpatentable over Niimi and Subramony in view of Ikakura et al., hereinafter "Ikakura" (U.S. Patent No. 6,255,230 B1).

Regarding claims 31-32, Ikakura discloses wherein process chamber comprises a batch type process chamber and comprises a single wafer process chamber [col. 9, lines 22-24].

It would have been obvious to one having ordinary skilled in the art at the time the invention was made to modify the teaching as discussed above of Niimi and Subramony as taught Ikakura for a purpose of improving the semiconductor microstructure.

Regarding claim 33, Niimi discloses a step of further comprising a process monitoring system and a pumping system [[0037] page 3].

Regarding claim 34, Niimi discloses wherein the substrate comprises Si and the oxynitride layer comprises Si₃N₄ [col. 2, lines 61-65].

Regarding claim 35, Niimi discloses the partial pressure of the nitrogen-containing oxidizing gas in the process chamber is less than about 5 Torr [col. 4, lines 34-35].

Regarding claim 36, Niimi discloses wherein the nitrogen-containing oxidizing gas comprises at least one of NO, N₂O, and NH₃ [col. 4, lines 39-41].

Regarding claim 37, Niimi discloses the process further comprises an oxygen-containing gas [col. 6, lines 12-15].

Regarding claim 38, Niimi discloses wherein the oxygen-containing gas comprises at least one of O₂, O₃, H₂O, and H₂O₂ [col. 6, lines 16-23].

Regarding claim 39, Niimi discloses wherein the process gas further comprises an inert gas [col. 4, lines 38-39].

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Regarding claim 40, Niimi discloses the process further comprises an inert gas which comprising at least one of Ar, He, Ne, Kr, Xe, N₂ [col. 4, lines 38-39].

Regarding claims 41-42, Niimi discloses the substrate temperature is between about 500°C and about 1000°C [col. 6, lines 41-43].

7. Claims 5 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Niimi in view of Solayappan et al., hereinafter "Solayappan" (U.S. Patent No. 5,997,642).

Regarding claim 5, Solayappan discloses the substrate diameter can be greater than about 195 nm [col. 9, lines 66-67].

It would have been obvious to one having ordinary skilled in the art at the time the invention was made to modify the teaching of the substrate diameter can be greater than about 195 nm of Niimi as taught by Solayappan for a purpose of improving the semiconductor microstructure process.

Regarding claim 22, Solayappan discloses the processing chamber pressure is below atmospheric pressure [col. 15, lines 65-col. 16, lines 1].

It would have been obvious to one having ordinary skilled in the art at the time the invention was made to modify the teaching of the processing chamber pressure is below atmospheric pressure of Niimi as taught by Solayappan for a purpose of improving the semiconductor microstructure process.

8. Claims 43-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Niimi and Subramony in view of Solayappan et al., hereinafter "Solayappan" (U.S. Patent No. 5,997,642).

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Regarding claim 43, Solayappan discloses the processing chamber pressure is below atmospheric pressure [col. 15, lines 65-col. 16, lines 1].

It would have been obvious to one having ordinary skilled in the art at the time the invention was made to modify the teaching of the processing chamber pressure is below atmospheric pressure of Niimi as taught by Solayappan for a purpose of improving the semiconductor microstructure process.

Regarding claim 44, Niimi discloses the partial pressure of the nitrogen-containing oxidizing gas in the process chamber is less than about 5 Torr [col. 4, lines 34-35].

9. Applicant argues that Niimi neither discloses nor teaches a step of nitridation of the insulating layer 103 is performed by another process. However, Niimi discloses the layer 103 is grown by a rapid thermal oxidation in a furnace (see col. 4, lines 18-25 and Figs. 1A-1B). As discussed above, Niimi does not discloses the oxynitride layer being formed in a self-limiting thermal oxidation process.

However, self-limiting thermal oxidation process is defined by the oxidation is applied at the low partial pressure of the processing gas comprising nitrogen-containing oxidizing gas as suggested by Niimi in col. 5, lines 52-56.

Thus, it would have been obvious to one having ordinary skilled in the art at the time the invention was made to modify the teaching of Niimi as discussed above such that the oxynitride layer being formed in a self-limiting thermal oxidation process for a purpose of improving the semiconductor microstructure.

Conclusion

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10. **THIS ACTION IS MADE FINAL.** Applicant is reminded of extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE MONTHS** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

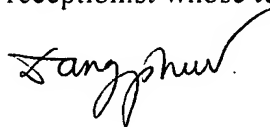
11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Phuc T. Dang whose telephone number is (571) 272-1776. The examiner can normally be reached on 8:00 am-5:00 pm.

12. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David C. Nelms can be reached on (571) 272-1787. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9306 for regular communications and After Final communications.

13. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Phuc T. Dang

PD



Primary Examiner

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